Shop-floor work organization in a lean factory: a set of indicators

Lluís Cuatrecasas Arbós, Jordi Olivella Nadal*

Affiliation
Department of Management
Technical University of Catalonia, Barcelona, 08034, Spain
* Corresponding author: Tel.: (34) 934137236; E-mail: jorge.olivella@upc.edu

ABSTRACT

Lean-production (LP) methodology is increasingly being used worldwide. Shop-floor work organization is a central aspect of analysing lean practices and supporting their implementation. This concept must first be precisely defined. The words "team" and "lean" have a range of very different meanings. We must define what we mean by teams in sociological systems, lean work in a broad sense and work organization for lean production. Work-organization practices appropriate for manufacturing or other activities that completely follow lean principles are known as work organization for lean production. Major studies of Toyota Production Systems and LP have set out the general principles to be followed by all areas of the company. Flow and kaizen summarize these principles, and both depend on how work is done on the shop floor. In spite of this, detailed work-organization practices are not described in the LP literature. Even though these practices do not define LP, more knowledge about them is required. Some aspects can vary from one case to another and over time, while others appear repeatedly in LP factories. In this paper, we analyse the literature. Based on this analysis, we propose seven policies and practices that define lean shop-floor work: standardization and control; training and learning; participation and empowerment; teamwork; multi-skilling and adaptability; common values; and compensation and prizes. Policies and practices that support lean implementation are deduced. We define a set of indicators to evaluate whether these policies and practices are applied in real cases and with what intensity. We consulted experts throughout the field about the indicators and their relation to LP. This study is part of a project aimed at obtaining tools to help companies with the work-organization aspects of LP implementation. The next steps will be to analyse real practices in various factories and study alternative methods and trends.

1. INTRODUCTION

The manufacturing practices developed by Taiichi Ohno at Toyota have greatly influenced production activities around the world. This phenomenon can be compared with the influence of the innovations of Henry Ford or Alfred Sloan, which turned one company's practice into a new management style.

The Toyota system – which Womack et al. (1990) called lean production (LP) – has been widely discussed in the literature. However, some aspects have scarcely been studied. We feel that the work-organization practices applied in companies that use LP methodologies are relatively underrepresented in the literature.

Work organization for LP varies greatly in different countries and companies. LP methodology is contingent on many aspects. The available suppliers and infrastructures, for example, determine how its principles are applied. Due to diversity in labour laws, cultural aspects and collective agreements, work organization requires a specific arrangement for each case.

This influences how knowledge in this area can be obtained. This paper analyses the principles of work organization in LP that appear in the literature. From these principles we deduce policies and practices that must be used by companies wishing to apply LP. We also propose indicators that reflect how a company is performing in different aspects related to policies and practices. For most of the indicators, a certain value indicates an LP organization. Nevertheless, most factories cannot apply LP principles completely. The indicators reflect the particular characteristics of each case: the degree of implementation and adaptation to the circumstances.

We have not included cellular manufacturing in this schema, in order to avoid focusing on assembly and similar activities. In any event, LP applies cellular manufacturing for any activity that allows it.

In Section 2, we differentiate work teams for LP from lean work teams in a broader sense. In Section 3, work-organization practices in LP factories are situated in LP methodology. Section 4 presents a series of principles that characterize work organization in lean production. From these principles, a set of policies and practices is obtained. Section 5 defines a set of indicators that reflect a company's behaviour in relation to these policies and practices. Finally, Section 6 presents our conclusions and proposes further research on this subject.

2. LEAN WORK TEAMS AND WORK TEAMS FOR LEAN PRODUCTION

In the literature, Toyota's techniques are called the Toyota Production System or lean production (LP). Nevertheless, this last expression is sometimes used to refer to practices only remotely related to Toyota methods. This is due in part to the way in which Toyota system concepts have been promoted.

The tools used to apply LP are better known than the method itself. LP is sometimes thought to be the simultaneous use of different production techniques. This is clearly erroneous. The LP non-waste philosophy gives rise to a set of tools, but the results obtained through their application are far greater than the sum of the results that each tool could generate. Nevertheless, LP is commonly associated with some of its tools.

This is especially true for work-organization aspects. The expression "lean work team" is used to denote teams with characteristics like task rotation, quality self-control and standardized methods. Nevertheless, the work actually done often has no relation to LP. There are two reasons for this fact:

- Work teams organized according to socio-technical theories are self-directed and autonomous. Teams that follow standardized methods and have a high level of discipline run very differently. In order to emphasize this difference, the word "lean" is used for the latter. What is really meant is "non-self-directed work teams". For example, Lorenz and Valeyre (2004) state that 28.2% of European companies have lean work teams. Certainly they don't mean that such a large number of companies apply LP in all of its facets.
- In LP treaties LP work organization aspects are subsumed on sections about quality, learning, company values and others (Clean (1993), Ohno (1993), Womack and Jones (1996) and Liker (2004)). Lean work characteristics are implicitly defined, but the lacks of a detailed formulation can lead to confusions in the use of the expression "lean work team".

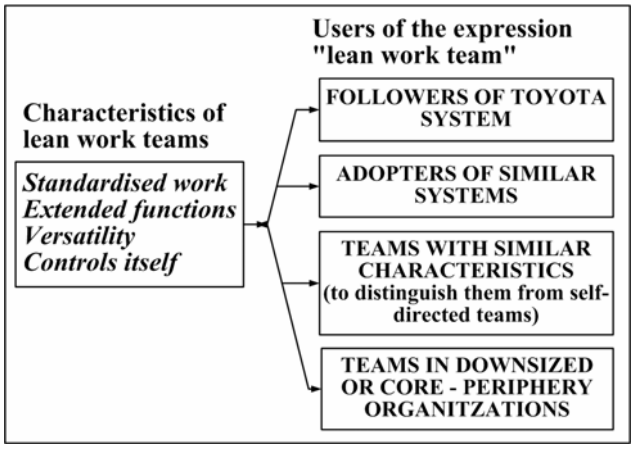

Figure 1. Meanings of the expression "lean work team".

While these two circumstances are related to LP methodology, the word "lean" is also used in a sense only remotely related to LP. It is used to refer to work performed in organizations that have eliminated many positions by outsourcing and using technology. The functions of certain jobs are extended and the requirements for workers change substantially (Holbeche, 1998).

In besides, some authors and companies have developed methodologies inspired by LP but which do not completely follow its principles. Osterman (2000) uses the expression "high-performance work organizations" to refer to organizations that use the following practices: self-directed work teams, total quality, quality circles and task rotation. The Modern Operating Agreement, reached between Chrysler and the American automobile union UAW, implied more worker functions, a drastic reduction in the number of categories, more front-line supervisors, the elimination of privileges that generate status, and the introduction of a participative culture (Hunter et al., 2002). Similar schemes were later adopted by other companies.

Therefore, we must distinguish between "lean work teams" and "work teams for lean production". "Lean work teams" is an expression used in many different contexts that refers to extended functions and strict control. Work teams for lean production are work teams created by applying LP.

Thus, four types of lean work teams can be distinguished. In order of their relation to LP, they are:

- Work teams at companies that have reduced their number of employees (Holbeche, 1998).
- Work teams that work autonomously but respect work standards and hierarchy (Lorenz and Valeyre, 2004).
- Teams at companies that apply methodologies inspired by LP or that have similar objectives.
- Teams at companies that follow or are looking to follow LP principles.

Our goal is to characterize the practices of companies that follow LP principles or try to do so. Figure 1 summarizes the ideas presented in this section.

3. WORK ORGANIZATION AS PART OF LM METHODOLOGY

LP methodology originated in Toyota's practices, which became known as "good practices" and were adapted to different situations. LP practices were promoted by former Toyota engineers while LP knowledge was mostly spread in the academic field by a few central works: Clean (1993), Ohno (1993), Womack and Jones (1996) and Liker (2004). These works describe the system by explaining its principles and the relationship between its principles and its results. Work-organization characteristics are not defined explicitly but the principles lead work to be organized in a certain way.

Figure 2 shows how work-organization practices relate to other aspects of LP. Our goal is not to offer a new interpretation of LM but to adopt a model that fits the

needs of this paper. LP practices can be summarized in two essential principles: perfect flow and continuous improvement. The other practices and tools are needed to cope with flow and to achieve continuous improvement.

LP techniques (just-in-time, single minute exchange of die, total productive maintenance and pull) and adequate worker performance make perfect flow possible. Continuous improvement requires appropriate product and equipment design and contributions from workers. Work organization therefore plays a critical and indispensable role in the method.

Cellular manufacturing is not included with the LP tools because we aim to describe very general principles (Hines et al., 2004). These principles can be applied to any situation. In factories and, more specifically, in the automotive industry, cellular manufacturing is a critical LP tool. When LP appeared in this industry, classic works included cellular manufacturing among their essential tools (Onho, 1988).

Work organization for lean production includes the following practices: standardization, learning, participation, teamwork, multi-skilling, common values, and compensation policy that supports LP. The rest of this paper details the characteristics of these practices and defines appropriate control indicators.

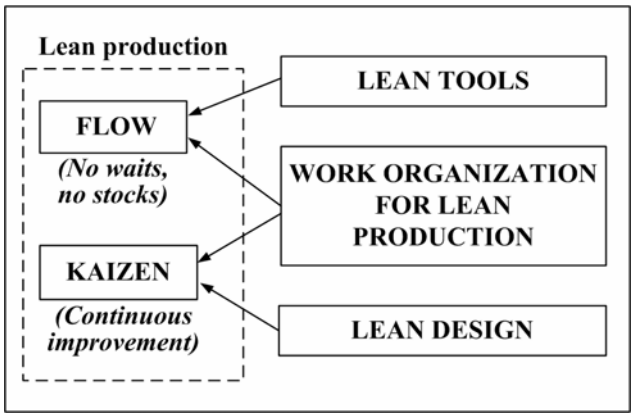

Figure 2. Meanings of the expression “lean work team”.

4. PRINCIPLES, POLICIES AND PRACTICES

4.1. METHODOLOGY

This paper characterizes work organization in factories that use LP principles and techniques and establishes a set of indicators that describe the most relevant factors for identifying LP behaviour. To do this, we associate LP with certain work-organization principles. We then deduce specific policies and practices from these principles. Finally, we associate these policies and practices with the appropriate indicators. Table 1 shows the first step by grouping seven generic principles in four categories.

The choices are not as important here as they may seem. The final goal is to obtain indicators to characterize work organization in LP factories. These principles are not intermediate goals but a guide for the process of determining policies, practices and indicators. Another list of principles could lead to the same indicators.

Table 1. Principles.

Work methods
Standardization and control (A)
Training and learning (B)
Functions of line workers
Participation and empowerment (C)
Task
Teamwork (D)
Multi-skilling and adaptability (E)
Commitment
Common values (F)
Compensation and prizes supporting LP (G)

This process is based on the literature. Eleven authoritative works have been selected: five books (Ohno, 1993, Womack et al., 1990, Monden, 1993, Crabill et al., 2000 and Liker, 2004) and six academic papers (Spear and Bowen, 1999, Cutcher-Gershenfeld et al., 1994, Forza, 1996, MacDuffie, 1995, Winfield, 1994 and Panizzolo, 1998). These works basically agree on work-organization aspects. Details are presented below.

4.2. PRINCIPLES

The principles in Table 1 are the first step toward characterizing lean work. This subsection presents certain aspects of each principle.

Standardization

Standardization is an essential principle of LP. Monden (Paez et al., 2004), Liker (2004) and others explicitly consider standardization a principle of LP. A perfect flow can be obtained and improvements can be made by establishing general methods. If each worker carries out his tasks in his own way, there is no basis for analysing possible improvements, calculations for flow stabilization cannot be performed and task rotation cannot be introduced without affecting flow.

The coexistence of participative work and standardization can be problematic. Workers can be discouraged from taking initiative if they are required to scrupulously follow work guidelines and compliance with these instructions is checked. Gilson et al. (2005) found that standardization moderates the relationship between creativity and team performance. This contradiction is a basic point in the controversy about the effect of LP on human resources. If standards originate in decisions made far from workers and must be followed exactly, Taylor’s vision is being applied rather than the Toyota system. In LP, the worker knows why the method applied is the best available, knows that he can participate in improving the method, and knows that all workers will use the improvements. He also knows that he can fill many positions in the plant, since work is performed according to standards and not personal methods. Thus,

standardization reinforces continuous improvement and is in fact an essential element of continuous improvement.

Training /learning

In LP, what happens on the line is critical to solving problems and developing improvements. Therefore, line workers must have a high degree of influence. A great deal of knowledge is found not in teams of engineers but in line workers. Manual workers become both learning and knowledge workers.

This new function is possible because line workers are close to what is happening. However, workers cannot cope with the responsibilities entrusted to them based on proximity alone. Training and learning are critical (Liker, 2004, principle 14). Line workers usually have vocational or technical training (Gorgeu and Mathieu, 2005).

Workers obtain knowledge from previous training, initial training, continuous training and, most importantly, from experience. Learning from work experience is known as learning-by-doing. Previous knowledge, organizational knowledge and teamwork reinforce and accelerate learning-by-doing, as demonstrated by Reagans et al. (2005).

Spear and Bowen (1999) analyse the Toyota learning mechanism. They argue that both personal and organizational learning are obtained by permanently questioning the appropriateness of methods through rigorous use of the scientific method.

Participation and empowerment

Since knowledge is found on the line, improvements and decisions must be analysed by people on the line. This idea was introduced by Liker (2004) as his 13th lean principle. Participation in decisions must go beyond simple consultation. Workers need to have influence and real power.

To do this, a leadership style that does not emphasize hierarchical superiority is introduced and a system of suggestions and planned discussion is established. Work teams are also assigned quality-control, maintenance and work-planning functions.

Teamwork

The concept of teamwork refers to joint and shared work. In companies, group work can occur at different levels and intensities. A worker can be a member of different groups simultaneously. In this sense, teamwork is always present in organizations. Nevertheless, when the organization is based on work teams, responsibilities (workloads, in particular) are assigned to teams. Performance measures are applied to the individual and to the team, and sometimes only to the team. Working in a work team implies a certain degree of control and mutual support – the greater the importance of the overall results to the members of the group, the greater the control and support.

These elements are common to all work teams. Other characteristics determine the differences between various types of work teams. These characteristics include:

- Degree of autonomy. Self-managed work teams make most everyday decisions, whereas other work teams strictly follow external guidelines.
- Homogeneity. A work team can be made up of people with clearly defined functions or can be based on multi-skilling. In extreme cases, all members of a team may have the same professional rank and be able to perform all tasks.
- Cooptation and training. Socialization of new members is a major task in organizations. In cases with more autonomy, work teams can choose and train new members. In other cases, teams may have no participation in hiring or training. Any intermediate solution is possible.

Work teams for LP must fit LP principles. Work teams are the heart of a LP factory (Womack et al. 1990, p. 9). An LP organization is based on work teams.

Basing organization on work teams is the final step in a process aimed at matching workers' skills to the company's needs (Gorgeu and Mathieu, 2005). In particular, multi-skilling makes it easier for production to meet demand by increasing the capacity to produce one combination of products or another.

In organizations of this type, workload is assigned to work teams. Planning therefore has two phases: the assignment of work to work teams and the distribution of tasks within work teams. Teams have a certain degree of autonomy in internal task distribution (Rahimifard, 2004). Leadership is participative, but autonomy is limited. The management assigns members to each team and the teams are assigned strictly defined duties (Amelsvoort and Venders, 1996)). There are fewer hierarchical levels and more members at each level than in traditional factories. Horizontal (non-hierarchical) coordination is critical (van der Meer and Gudim, 1996).

Multi-skilling and adaptability

Multi-skilling is inherent to work teams for LP. Multi-skilling implies flexibility, provides team members with an overall vision of the work and facilitates learning and continuous improvement. The time spent training for new tasks limits multi-skilling, but also makes it useful. Indeed, long training periods can make multi-skilling expensive and even unadvisable (Allwood and Lee, 2004). However, a task that requires a very short training period can be performed whenever necessary, which therefore makes multi-skilling immediate. Multi-skilling is usefu when training time is substantial but affordable. This is the case for assembly lines, for instance. Multi-skilling is effective when task rotation is performed systematically.

New tasks must be learned not only to achieve multi-skilling but also in response to changes in products or processes. Adaptability is an indispensable quality in LP work. Discipline is necessary for adaptability because it facilitates strict compliance with standards (Winfield, 1994). On the collective scale, adaptability requires that the necessary number of workers – and no more – are available at all times.

Common values

Workers must be committed to the company's values in order to apply LP (Spear and Bowen, 1999 and Cutcher-Gershenfeld et al., 1994). From this point of view, LP is related to the style of labour relations described by Ouchi and Price (1978). This study cites two well-known non-Japanese companies as examples of Type Z companies: IBM and Hewlett-Packard. These companies have no relationship with LP methods. In LP organizations, workers are deeply commited to the company, but this characteristic is also present in other companies.

Various studies have found differences between Japan and Western countries in terms of achieving commitment. In Japan, integration is facilitated through social relations between team members outside of work. In Europe, social relations of this type are not common and leadership is essential (Winfield, 1994).

Compensation and prizes to support LP

Compensation is a part of any human-resources policy and must serve the objectives of this policy. Compensation to support LP must be based on skills (that is, what the worker can to do) and team performance (Sodenkamp et al., 2005). Skill-based compensation rewards learning, multi-skilling and teamwork. Performance-based compensation increases commitment. Finally, offering prizes for ideas boosts participation and continuous improvement.

4.3. POLICIES AND PRACTICES

The principles described above lead to a set of policies and practices. Policies are tendencies or intentions that guide action. The decision that "communications must be direct and unambiguous" and the intention to "integrate workers in work teams" are policies. It is difficult to establish indicators of the degree to which these policies are actually implemented. In some cases, the indicator is the existence of instructions to fulfil these objectives, which does not guarantee that they are actually reached. The principles described above include basic elements of LP that must be included even if it is unclear whether they can be controlled.

Whenever possible, principles are transformed into practices. Practices are specific behaviours. Group members electing a leader and task rotation are two examples of practices.

Table 2 lists policies and practices under their corresponding principles. References to authoritative works on LP are included to justify the inclusion of the principles, policies and practices.

Table 2. Practices and policies.

Standardization and control [a,c,d,e]
• Production and task processes are standardized and documented. [h,f,e]
• One team member leads and strictly controls the team. [j]
• A leader who is not a team member is responsible for control. [g]
• Work teams are coordinated with suppliers and internal clients. [h]
• Workers are instructed to communicate clearly and unambiguously. [c,f]
Training and learning [b,e,k]
• Learning capacity is valued in hiring. [i]
• Prolonged initial training period. [i]
• Substantial time dedicated to training existing workers. [i]
• General knowledge of quality control and LP. [b,d,h]
• Rigorous and formal system for analysis and problem solving. [c,f]
• Leaders are trained to be experts in their work, live by the philosophy and teach others. [d,e]
Participation [c] **and empowerment** [b,k]
• Meetings with the participation of workers to solve problems and introduce improvements. [c, g,h,f,k]
• Participation by obtaining and applying suggestions. [c,h,i, j]
• Interaction between workers, supervisors and specialized workers. [c,h]
• Work teams have quality-control responsibilities. [b,c,d,g,i]
• Work teams have work-planning responsibilities. [g]
• Work teams have maintenance responsibilities. [h]
• Visual information [b,c,d,e] on quality, [g,h] safety [g] and productivity.
• Autonomy of workers (the line can be stopped if quality problems are detected). [h]
• Work teams have management responsibilities. [g]
Teamwork [a,b,d]
• Work teams. [g,h,i]
• Supervisors encourage teamwork. [a,h]
• Activities are carried out to obtain team cohesion. [j]
• Common work space for team members. [g]
• Personalization of spaces. [h]
• Interpersonal skills are valued in hiring. [i]
Multi-skilling and adaptability [c,j]
• Multi-skilling of workers. [b,c,d,h,j,k]
• Task rotation. [b,c,i]
• Visual information [b,c,d,e] on progress in skills. [g]
• Acceptance of authority (discipline) is valued in hiring. [j]
• The number of employees is adapted to needs at all times. [c,k]
• Flexible job classifications and few hierarchical levels. [a,c]
Common values [j]
• Employees are committed to improvement. [h,k]
• Employees are committed to learning. [h]
• A culture of quality is cultivated. [e]
• Employee participation is encouraged and supported. [d,i]
• No barriers between managers and workers. [i]
• Quality of life in the workplace. [c,j]

Compensation and prizes to support LP

- Prizes for applied ideas. [c]
- Visual information on prizes. [e,g]
- Innovative performance measures and performance-based compensation. [k]
- Compensation based on overall performance (plant or work team). [i]
- Skill-based compensation. [i]

References in the table

a. Ohno (1993); b. Womack et al. (1990); c. Monden (1993); d. Crabill et al. (2000); e. Liker (2004); f. Spear and Bowen (1999); g. Cutcher-Gershenfeld et al. (1994); h. Forza (1996); i. MacDuffie (1995); j. Winfield (1994); k. Panizzolo (1998).

5. INDICATORS

The previous sections have summarized a set of characteristics of LP work based on the literature. Some of these events may or may not occur (such as the interruption of the line due to quality problems). Some allow various degrees of implementation (such as task rotation). Still others can only be measured approximately (such as workers' commitment to quality).

Our goal now is to obtain measures that can easily be applied in different plants and in different situations in the same plant. A detailed measure of all factors is impossible. In fact, the different factors are highly correlated and the lack of information can often be overcome. It is very difficult to measure commitment to quality, but if work teams are in charge of quality and they perform well, we can reasonably consider that a culture of quality exists.

Table 3 presents indicators of the more visible factors, some of which have been reported by Bacon and Blyton (2000), Forza (1996), Karlsson and Ahlstrom, (1996), Lorenz and Valeyre (2004) and MacDuffie (1995). We also consulted with experts throughout the field about the indicators and their relation to LP. When the fulfilment or high achievement of an indicator is considered characteristic of a LP organization, it is identified as PR (positive relation). The inverse case is marked as NR (negative relation). Two indicators are considered contextual (C), meaning that they are relevant for characterizing work organization but can take different values even among companies that follow LP principles.

Table 3. Indicators.

A. STANDARDIZATION

Formalization of procedures

A1. All production processes are standardized and documented. (PR)

A2. For each task, the content, sequence, terms and expected results are defined. (PR)

Control

A3. One team member leads the team and strictly controls work. (PR)

A4. A leader who is not a team member controls and supervises several teams. (PR)

Coordination

A5. Work teams are coordinated with suppliers and internal clients. (PR)

A6. Workers are explicitly instructed to communicate clearly and unambiguously. (PR)

B. TRAINING AND LEARNING

Hiring criteria

B1. Vocational or technical training is required to be hired as a line worker.

B2. When hiring workers, supervisors or specialized workers, the fit between existing skills and the job requirements is not highly valued. (PR)

B3. When hiring workers, supervisors or specialized workers, a willingness to learn new skills is highly valued. (PR)

Time dedicated to training

B4. The time dedicated to training by workers, supervisors and specialized workers in their first 6 months of work. (PR)

B5. The time dedicated to training by existing workers, supervisors and specialized workers in a year. (PR)

Quality control and LP knowledge

B6. Proportion of workers, supervisors and specialized workers with quality-control knowledge. (PR)

B7. Proportion of workers, supervisors and specialized workers that have LP knowledge and a general vision of the process. (PR)

Learning by solving problems

B8. A formal analysis and problem-solving system is in place. (PR)

C. PARTICIPATION AND EMPOWERMENT

Participation in conflict resolution and improvements

C1. Conflicts are discussed in meetings with the participation of the workers. (PR)

C2. Improvement groups and quality circles are created and work systematically. (PR)

C3. There are communication channels between workers and specialized workers. (PR)

C4. There are communication channels between workers and managers. (PR)

C5. Percentage of workers who made suggestions in a year. (PR)

C6. Percentage of workers' suggestions that were applied. (PR)

Participation in quality

C7. Work teams' degree of responsibility for quality control (1. No external controls, 2. External controls for complex aspects, 3. Some responsibilities, 4. No responsibility). (PR)

C8. Percentage of workers who participate in quality control. (PR)

C9. Workers detect quality problems, identify and reject defective parts, and stop the line. (PR)

C10. Workers help determine non-quality causes, the level required and improvement activities. (PR)

C11. Work teams receive daily information about non-quality rates. (PR)

Participation in maintenance

C12. Work teams' degree of responsibility for maintenance. (1. No external controls, 2. External controls for complex aspects, 3. Some responsibilities, 4. No responsibility). (PR)

C13. Percentage of workers who participate in maintenance. (PR)

Participation in work planning and performance

C14. Work teams' degree of responsibility for work planning (1. No external controls, 2. External controls for complex aspects, 3. Some responsibilities, 4. No responsibility). (PR)

C15. Work teams receive daily information about productivity rates. (PR)

C16. Information about a team member's performance is available at all times. (PR)

Participation in safety

C17. Work teams participate in describing and evaluating the risks of each job. (PR)

C18. Work teams participate in establishing corrective measures, individual and collective protections, and evacuation and emergency plans. (PR)

C19. Visual information on the shop floor about accident rates and causes. (PR)

Autonomy of work teams

C20. The leader is chosen by team members or by rotation. (C)

C21. Work teams participate in hiring processes. (C)

D. TEAMWORK

Work teams

D1. Percentage of shop-floor workers who participle in work teams. (PR)

D2. Percentage of tasks of the flow that are done by work teams. (PR).

Teamwork support

D3. Supervisors encourage workers to cooperate with one another. (PR)

D4. Activities are carried out to improve team cohesion. (PR)

D5. Common work space for team members. (PR)

D6. Personalization of team spaces. (PR)

Valuing interpersonal skills

D7. In hiring workers, supervisors or specialized workers, interpersonal skills (the ability to work with others) are highly valued. (PR)

E. MULTI-SKILLING AND ADAPTABILITY

Multi-skilling

E1. Number of tasks that the more multi-skilled workers are able to do. (PR)

E2. Minimum number of tasks that a worker must be able to do. (PR)

Adaptability

E6. In hiring workers, supervisors or specialized workers, acceptance of authority (discipline) is highly valued. (PR)

E7. Mechanisms are in place to fit the current number of employees to needs. (PR)

Job classification

E8. Job descriptions prioritize flexibility. (PR)

E9. Number of jobs described. (NR)

E10. Number of hierarchical levels among production-related jobs. (NR)

F. COMMON VALUES

Commitment

F1. Meetings about problems and improvements are usual. (PR)

F2. Workers take part in designing training programs. (PR)

F3. Workers are given information on the overall situation and prospects of the company. (PR)

F4. Activities are organized to give workers some knowledge about the different aspects of the company's activity. (PR)

Absence of barriers between managers and workers

F5. Same uniform. (PR)

F6. Same cafeteria. (PR)

F7. Same car park. (PR)

F8. No ties. (PR)

Quality of life in the workplace

F9. Programs to help employees balance work and family life. (PR)

F10. Job enrichment to encourage the personal progress of workers. (PR)

G. COMPENSATION AND PRIZES TO SUPPORT LP

Prizes

G1. Prizes for applied ideas. (PR)

G2. Visual information on prizes. (PR)

Compensation

G3. Compensation based on plant performance. (PR)

G4. Compensation based on work-team performance. (PR)

G5. Skill-based compensation. (PR)

5. CONCLUSIONS

The major LP works do not include a detailed description of work organization. In spite of this, a set of principles, policies and practices that characterize work organization in LP can be established based on the principles and success cases of lean production and the literature on the subject.

Based on the literature, this work deduces seven principles that summarize how a LP organization is

supposed to organize work. A set of specific policies and practices is obtained from these principles. Finally, the policies and practices are associated with indicators of the company or factory's activity. Experts throughout the field were consulted about the indicators and their relation to LP.

In future research, one or more LP factories should be analysed to validate the meaningfulness of the indicators. After this validation, the set of indicators can be used to obtain a broader analysis of work-organization characteristics in LP companies and factories.

REFERENCES

Allwood, J. M.; Lee, W. L., 2004, "The Impact of Job Rotation on Problem Solving Skills." In International Journal of Production Research, Vol. 42, No5., pp.865-881.

Crabill, J.; Harmon, E.; Meadows, D.; Milauskas, R.; Miller, C.; Nightingale, D.; Schwartz, B.; Shields, T.; Torrani, B., 2000, "Production Operations Level Transition-To-Lean Description Manual." Center for Technology, Policy, and Industrial Development. Massachusetts Institute of Technology.

Cutcher-Gershenfeld, J.; Nitta, M.; Barrett, B.; Belhedi, N.; Bullard, J.; Coutchie, C.; Inaba, T.; Ishino, I.; Seepa, L.; Wen-Jeng, L.; Mothersell, W.; Rabine, S.; Ramanand, S.; Strolle, M.; Wheaton, A., 1994, "Japanese Team-Based Work Systems in North America: Explaining the Diversity." In California Management Review, Vol. 42, No. 1, pp. 42-64.

Forza, C., 1996, "Work Organisation in Lean Production and Traditional Plants: What Are the Differences?" In International Journal of Operations and Production Management, Vol. 16, No. 2, pp. 42-62.

Gilson, L. L.; Mathieu, J. E.; Shalley, C. E.; Ruddy, T. M., 2005, "Creativity and Standardization: Complementary or Conflicting Drivers of Team Effectiveness?" In Academy Of Management Journal, Vol. 48, No. 3, pp. 521-531.

Gorgeu, A.; Mathieu, R., 2005, "Teamwork in Factories within the French Automobile Industry." In New Technology, Work and Employment, Vol. 8, No.2, pp.88-101.

Hines, P.; Holwe, M.; Rich, N, 2004. "Learning to Evolve: A Review of Contemporary Lean Thinking." In International Journal of Operations and Production Management, Vol. 24, No. 9-10, pp. 994-1011.

Holbeche, L., 1998, Motivating People in Lean Organizations. Oxford; Boston: Butterworth-Heinemann.

Hunter, L. W.; MacDuffie, J. P.; Doucet, L., 2002, "What Makes Teams Take? Employee Reactions to Work Reforms." In Industrial and Labor Relations Review, Vol. 55, No.3, pp.448-472.

Liker, J. K., 2004, The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer. New York: McGraw-Hill.

Lorenz, E.; Valeyre, A., 2004, "Les formes d'organisation du travail dans les pays de l'union européenne." In Documents de travail: Centre d'Etudes de l'Emploi.

MacDuffie, J. P., 1995, "Human Resource Bundles and Manufacturing Performance: Organizational Logic and Flexible Production Systems in the World Auto Industry." In Industrial and Labor Relations Review, Vol. 48, No.2, pp. 197-221.

Monden, Y., 1993, Toyota Production System: An Integrated Approach to Just-in-Time. 2nd ed. Norcross, Ga.: Industrial Engineering and Management Press.

Ohno, T., 1988, Toyota Production System: Beyond Large-Scale Production. Portland: Productivity Press.

Osterman, P., 2000, "Work Reorganization in an Era of Restructuring: Trends in Diffusion and Effects on Employee Welfare." In Industrial and Labor Relations Review, Vol. 53, No.2, pp.196.

Ouchi, W. G.; Price, R. L., 1978, Hierarchies, Clans, and Theory-Z – A New Perspective on Organization-Development. In Organizational Dynamics, Vol. 7, No. 2, pp. 24-44.

Paez, O.; Dewees, J.; Genaidy, A.; Tuncel, S.; Karwowski, W.; Zurada, J., 2004, "The Lean Manufacturing Enterprise: An Emerging Sociotechnological System Integration." In Human Factors and Ergonomics in Manufacturing, Vol. 14, No. 3, pp. 285-306.

##Panizzolo, R., 1998, Applying the Lessons Learned from 27 Lean Manufacturers: The Relevance of Relationships Management. International Journal of Production Economics. Vol. 55, No. 3, p. 223.

Rahimifard, S., 2004, "Semi-Heterarchical Production Planning Structures in the Support of Team-Based Manufacturing." In International Journal of Production Research, Vol.42 , No.17, pp. 3369-3382.

Reagans, R.; Argote, L.; Brooks, D., 2005, "Individual Experience and Experience Working Together: Predicting Learning Rates from Knowing Who Knows What and Knowing How to Work Together." In Management Science, Vol. 51, No. 6, pp. 869-881.

Sodenkamp, D.; Schmidt, K. H.; Kleinbeck, U., 2005, "Self-Management of Work Groups through Corporate Values: From Theory to Practice." In International Journal of Manpower, Vol. 26, No. 1, pp. 67-79.

Spear, S.; Bowen, H. K., 1999, "Decoding the DNA of the Toyota Production System." In Harvard Business Review, Vol. 77, No.5, pp. 96-106.

van Amelsvoort, P.; Venders, J., 1996, "Team Time: A Model for Developing Self-Directed Work Teams." In International Journal of Operations & Production Management, Vol. 16, No.2, pp.159-170.

van der Meer, R.; Gudim, M., 1996, "The Role Of Group Working In Assembly Organization." In International Journal of Operations & Production Management, Vol. 16, No.2, pp.119-140.

Winfield, I., 1994, Toyota UK Ltd: Model HRM Practices?. In Employee Relations, Vol. 16, No. 1, pp. 41.

Womack, J. P.; Jones, D. T., 1996, Lean Thinking: Banish Waste and Create Wealth in Your Corporation. New York: Free Press.

Womack, J. P.; Jones, D. T.; Roos, D., 1990, The Machine that Changed the World. New York: Rawson Associates.